

# REF02

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## +5V Precision VOLTAGE REFERENCE

### FEATURES

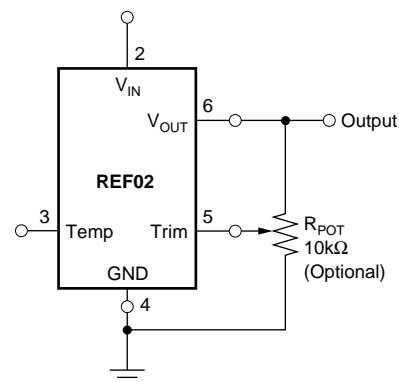
- **OUTPUT VOLTAGE:** +5V  $\pm 0.2\%$  max
- **EXCELLENT TEMPERATURE STABILITY:** 10ppm/ $^{\circ}\text{C}$  max ( $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )
- **LOW NOISE:** 10 $\mu\text{V}$ p-p max (0.1Hz to 10Hz)
- **EXCELLENT LINE REGULATION:** 0.01%/V max
- **EXCELLENT LOAD REGULATION:** 0.008%/mA max
- **LOW SUPPLY CURRENT:** 1.4mA max
- **SHORT-CIRCUIT PROTECTED**
- **WIDE SUPPLY RANGE:** 8V to 40V
- **INDUSTRIAL TEMPERATURE RANGE:**  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- **PACKAGE OPTIONS:** DIP-8, SO-8

### DESCRIPTION

The REF02 is a precision 5V voltage reference. The drift is laser trimmed to 10ppm/ $^{\circ}\text{C}$  max over the extended industrial and military temperature range. The REF02 provides a stable 5V output that can be externally adjusted over a  $\pm 6\%$  range with minimal effect on temperature stability. The REF02 operates from a single supply with an input range of 8V to 40V with a very low current drain of 1mA, and excellent temperature stability due to an improved design. Excellent line and load regulation, low noise, low power, and low cost make the REF02 the best choice whenever a 5V voltage reference is required. All popular package options are available: plastic DIP, and SO. The REF02 is an ideal choice for portable instrumentation, temperature transducers, Analog-to-Digital (A/D) and Digital-to-Analog (D/A) converters, and digital voltmeters.

### APPLICATIONS

- PRECISION REGULATORS
- CONSTANT CURRENT SOURCE/SINK
- DIGITAL VOLTMETERS
- V/F CONVERTERS
- A/D AND D/A CONVERTERS
- PRECISION CALIBRATION STANDARD
- TEST EQUIPMENT



+5V Reference with Trimmed Output

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# SPECIFICATIONS

## ELECTRICAL

At  $T_A = +25^\circ\text{C}$  and  $V_{IN} = +15\text{V}$  power supply, unless otherwise noted.

PARAMETER	CONDITIONS	REF02A			REF02B			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
<b>OUTPUT VOLTAGE</b> Change with Temperature <sup>(1, 2)</sup> ( $\Delta V_{OT}$ ) -40°C to +85°C	$I_{LOAD} = 0\text{mA}$	4.985	5.0	5.015	4.990	*	5.010	V
			0.05	0.19		0.05	0.13	%
<b>OUTPUT VOLTAGE DRIFT</b> <sup>(3)</sup> -40°C to +85°C ( $TCV_O$ )			4	15		4	10	$\pm\text{ppm}/^\circ\text{C}$
<b>LONG-TERM STABILITY</b> First 1000h Second 1000h	2000h Test		100			100		$\pm\text{ppm}$
			50			50		$\pm\text{ppm}$
<b>OUTPUT ADJUSTMENT RANGE</b>	$R_{POT} = 10\text{k}\Omega$ <sup>(6)</sup>	$\pm 3$	$\pm 6$		*	*		%
<b>CHANGE IN <math>V_O</math> TEMP COEFFICIENT WITH OUTPUT ADJUSTMENT</b> (-55°C to +125°C)	$R_{POT} = 10\text{k}\Omega$		0.7			*		ppm/%
<b>OUTPUT VOLTAGE NOISE</b>	0.1Hz to 10Hz <sup>(5)</sup>		4	10		*	*	$\mu\text{Vp-p}$
<b>LINE REGULATION</b> <sup>(4)</sup> -40°C to +85°C	$V_{IN} = 8\text{V to } 33\text{V}$ $V_{IN} = 8.5\text{V to } 33\text{V}$		0.006	0.010		*	*	%/V
			0.008	0.012		*	*	
<b>LOAD REGULATION</b> <sup>(4)</sup> -40°C to +85°C	$I_L = 0\text{mA to } +10\text{mA}$ $I_L = 0\text{mA to } +10\text{mA}$		0.005	0.010		*	0.008	%/mA
			0.007	0.012		*	0.010	
<b>TURN-ON SETTLING TIME</b>	$T_o \pm 0.1\%$ of Final Value		5			*		$\mu\text{s}$
<b>QUIESCENT CURRENT</b>	No Load		1.0	1.4		*	*	mA
<b>LOAD CURRENT (SOURCE)</b>		10	21		*	*		mA
<b>LOAD CURRENT (SINK)</b>		-0.3	-0.5		*	*		mA
<b>SHORT-CIRCUIT CURRENT</b>	$V_{OUT} = 0$		30			*		mA
<b>POWER DISSIPATION</b>	No Load		15	21		*	*	mW
<b>TEMPERATURE VOLTAGE OUTPUT</b> <sup>(7)</sup>			630			*		mV
<b>TEMPERATURE COEFFICIENT</b> of Temperature Pin Voltage -55°C to +125°C			2.1					$\text{mV}/^\circ\text{C}$
<b>TEMPERATURE RANGE</b> Specification REF02A, B, C		-40		+85	*		*	$^\circ\text{C}$

NOTES: (1)  $\Delta V_{OT}$  is defined as the absolute difference between the maximum output and the minimum output voltage over the specified temperature range expressed as a percentage of 5V:  $\Delta V_O = \left| \frac{V_{MAX} - V_{MIN}}{5\text{V}} \right| \times 100$  (2)  $\Delta V_{OT}$  specification applies trimmed to +5.000V or untrimmed. (3)  $TCV_O$  is defined as  $\Delta V_{OT}$  divided by

the temperature range. (4) Line and load regulation specifications include the effect of self heating. (5) Sample tested. (6) 10k $\Omega$  potentiometer connected between  $V_{OUT}$  and ground with wiper connected to Trim pin. See Figure on page 1. (7) Pin 3 is insensitive to capacitive loading. The temperature voltage will be modified by 7mV for each  $\mu\text{A}$  of loading.

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## ABSOLUTE MAXIMUM RATINGS

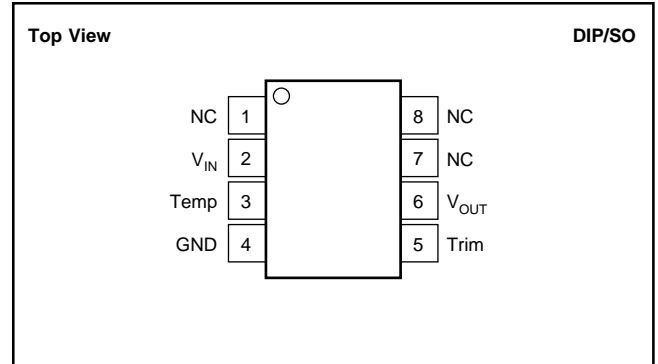
Input Voltage .....	+40V
Operating Temperature	
P, U .....	-40°C to +85°C
Storage Temperature Range	
P, U .....	-65°C to +125°
Output Short Circuit Duration (to Ground or $V_{IN}$ ) .....	Indefinite
Junction Temperature .....	-65°C to +150°
$\theta_{JA}$ P .....	120°C/W
U .....	80°C/W
Lead Temperature (soldering, 60s) .....	+300°C

## ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## PIN CONFIGURATIONS

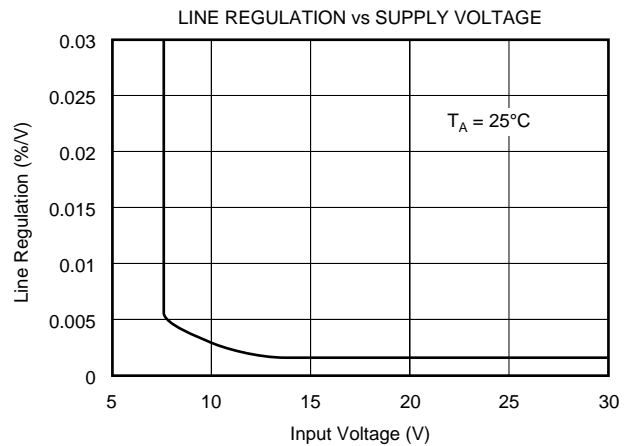
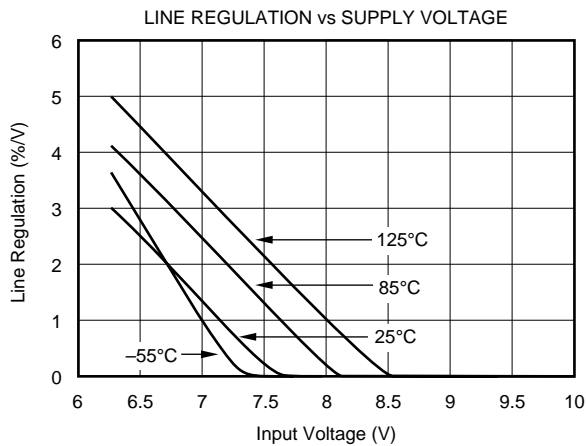
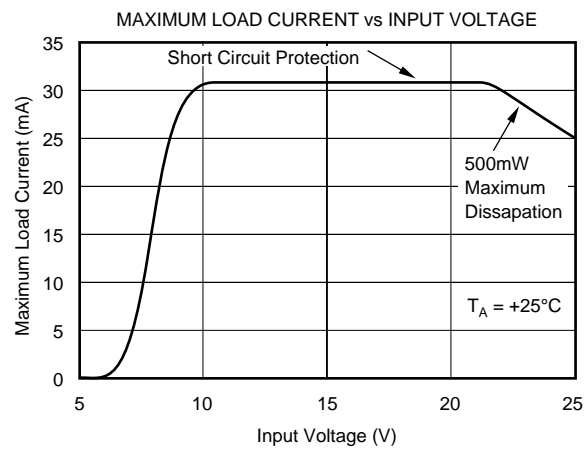
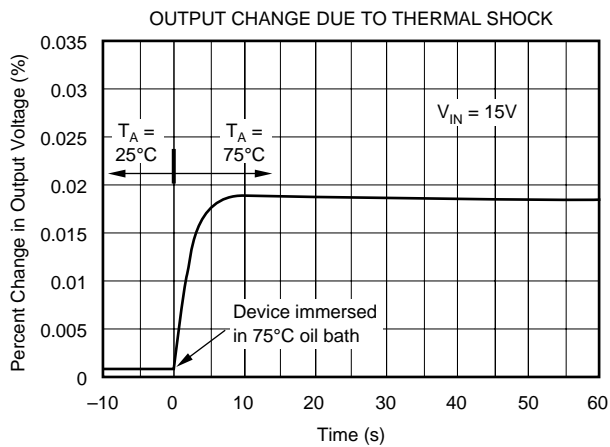
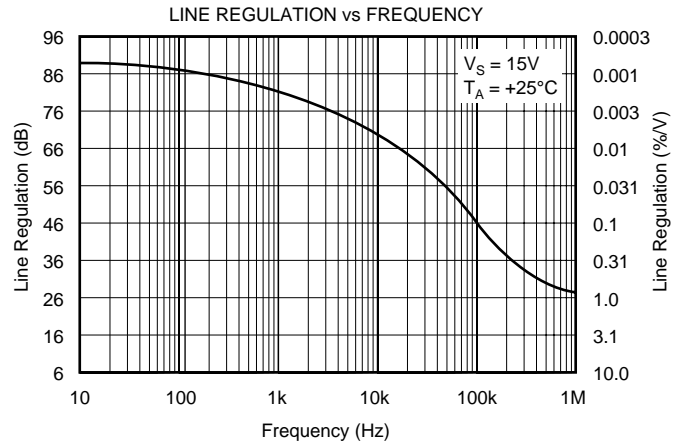
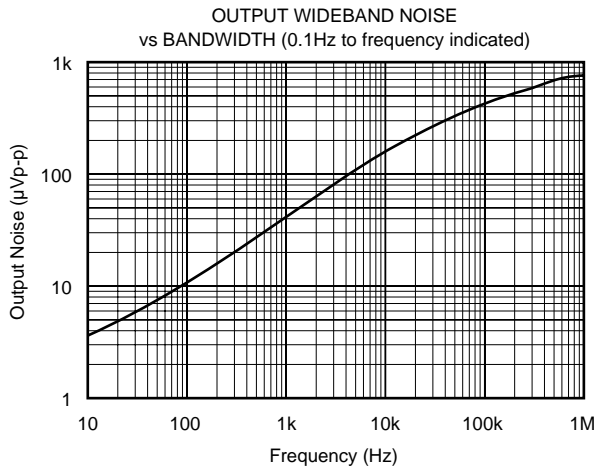


## PACKAGE/ORDERING INFORMATION

PRODUCT	$V_{OUT}$ at 25°C	MAX DRIFT (ppm/°C)	PACKAGE	PACKAGE DRAWING NUMBER	SPECIFICATION TEMPERATURE RANGE	ORDERING NUMBER	TRANSPORT MEDIA
REF02AU	5V±15mV	±15	SO-8	182	-40°C to +85°C	—	—
REF02BU	5V±10mV	±10	SO-8	182	-40°C to +85°C	—	—
REF02AP	5V±15mV	±15	DIP-8	006	-40°C to +85°C	—	—
REF02BP	5V±10mV	±10	DIP-8	006	-40°C to +85°C	—	—

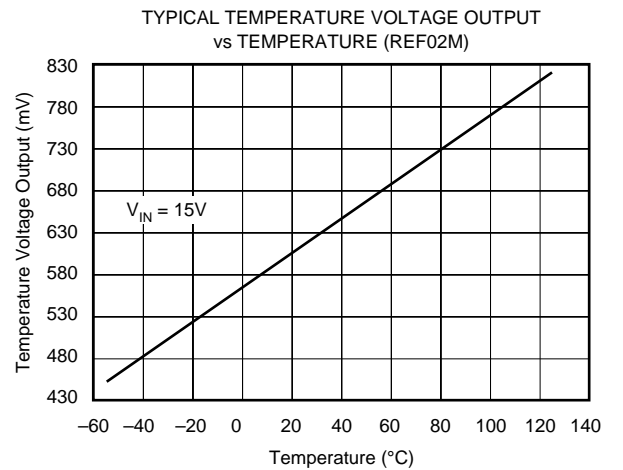
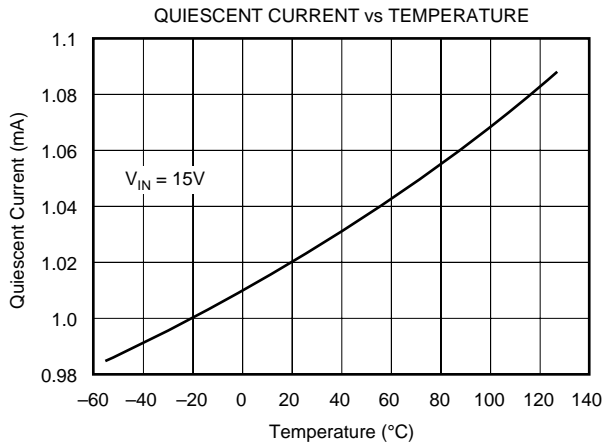
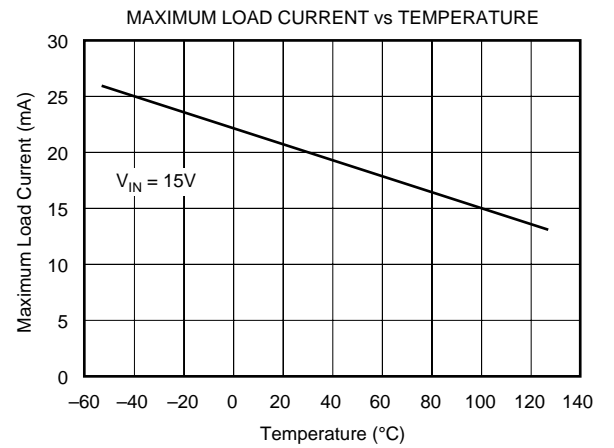
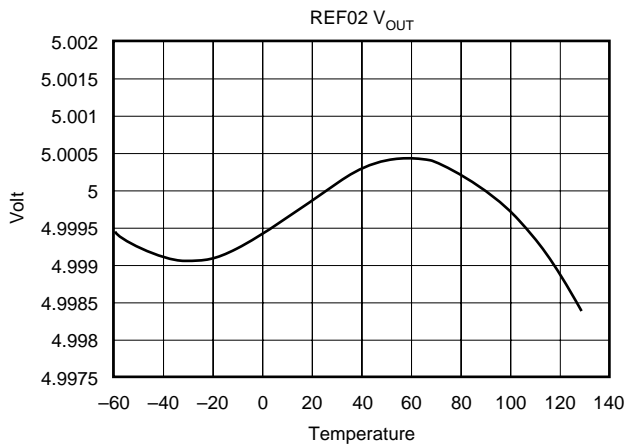
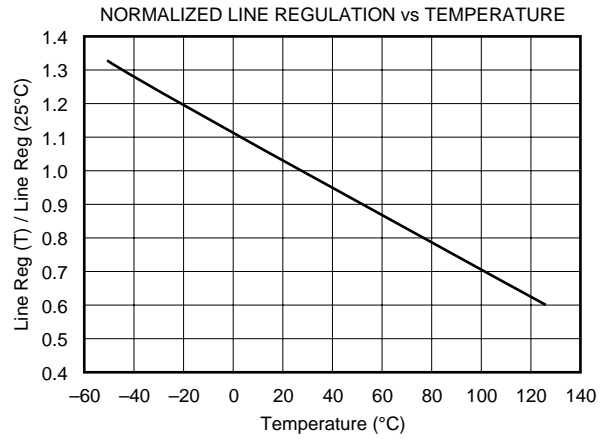
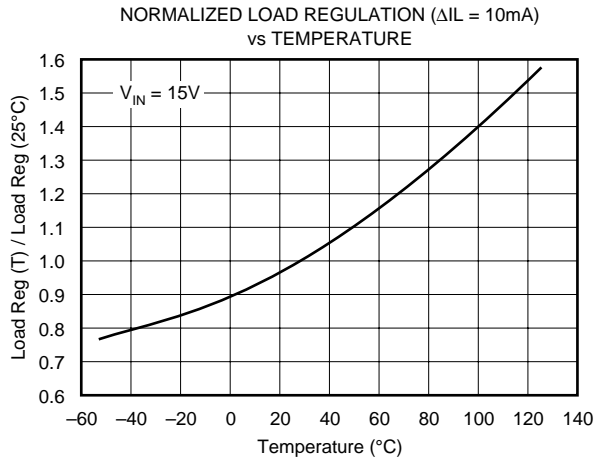
# TYPICAL PERFORMANCE CURVES

AT  $T_A = +25^\circ\text{C}$ , unless otherwise noted.



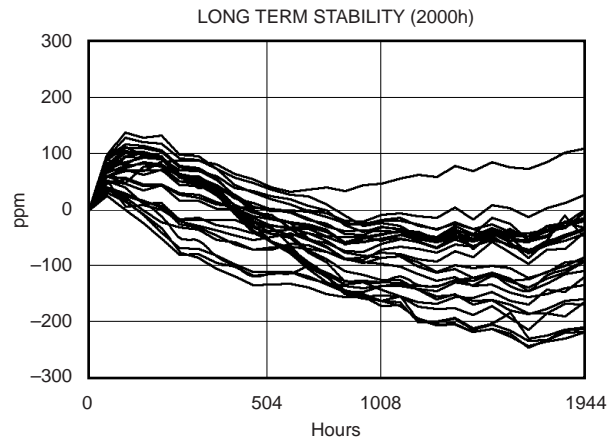
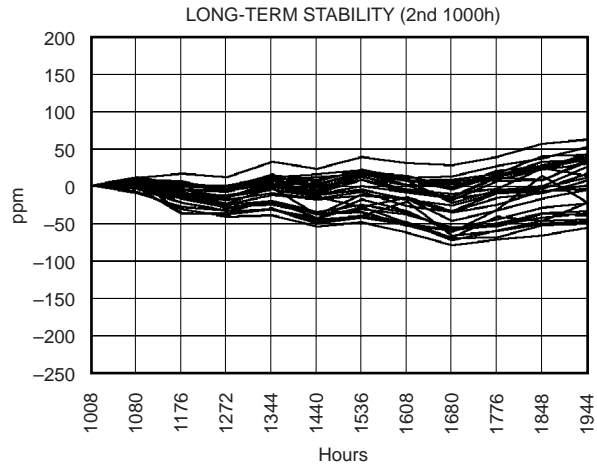
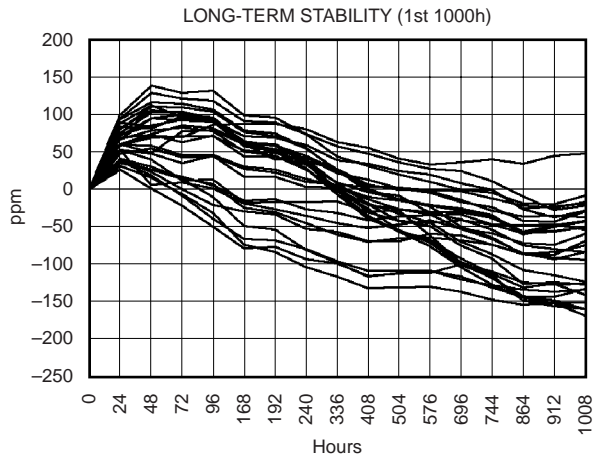
# TYPICAL PERFORMANCE CURVES (Cont.)

At  $T_A = +25^\circ\text{C}$ , unless otherwise noted.



# TYPICAL PERFORMANCE CURVES (Cont.)

At  $T_A = +25^\circ\text{C}$ , unless otherwise noted.



## OUTPUT ADJUSTMENT

The REF02 trim terminal can be used to adjust the voltage over a 5V  $\pm$ 150mV range. This feature allows the system designer to trim system errors by setting the reference to a voltage other than 5V, including 5.12V<sup>(1)</sup> for binary applications (see circuit on page one).

Adjustment of the output does not significantly affect the temperature performance of the device. The temperature coefficient change is approximately 0.7ppm/ $^{\circ}$ C for 100mV of output adjustment.

NOTE: (1) 20mV LSB for 8-bit applications.

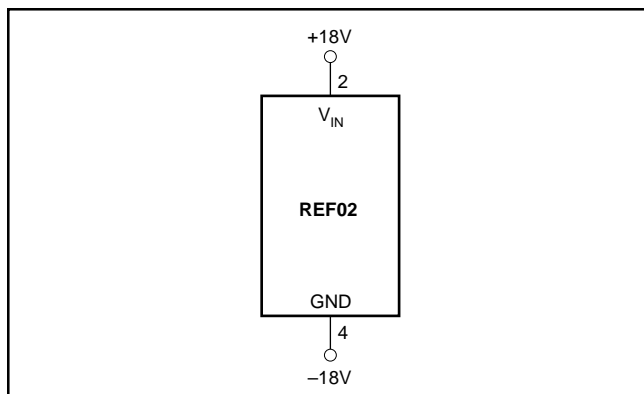


FIGURE 1. Burn-In Circuit.

## REFERENCE STACKING PROVIDES OUTSTANDING LINE REGULATION

By stacking two REF01s and one REF02, a systems designer can achieve 5V, 15V, and 25V outputs. One very important advantage of this circuit is the near perfect line regulation at 5V and 15V outputs. This circuit can accept a 27V to 55V change to the input with less than the noise voltage as a change to the output voltage. R<sub>B</sub>, a load bypass resistor, supplies current I<sub>SY</sub> for the 15V regulator.

Any number of REF01s and REF02s can be stacked in this configuration. For example, if ten devices can be stacked in this configuration, ten 5V or five 10V outputs are achieved. The line voltage may range from 100V to 130V. Care should be exercised to insure that the total load currents do not exceed the maximum usable current, which is typically 21mA.

## TYPICAL APPLICATIONS

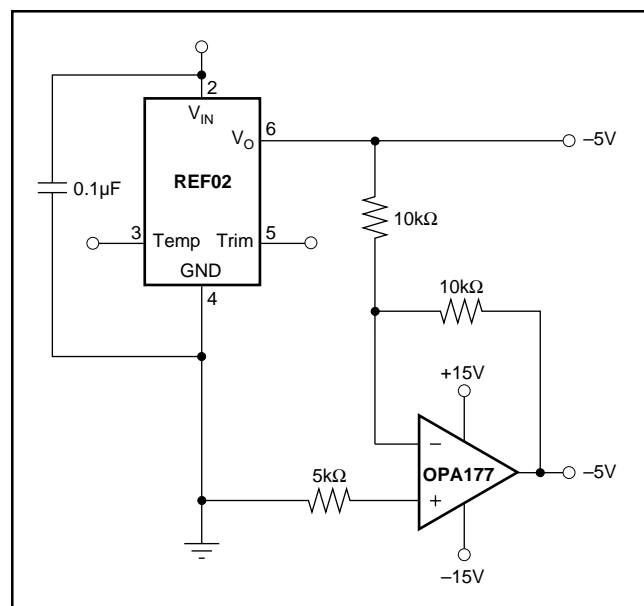


FIGURE 2.  $\pm$ 5V Precision Reference.

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**PACKAGING INFORMATION**

ORDERABLE DEVICE	STATUS(1)	PACKAGE TYPE	PACKAGE DRAWING	PINS	PACKAGE QTY
REF02AP	ACTIVE	PDIP	P	8	50
REF02AU	ACTIVE	SOIC	D	8	100
REF02AU/2K5	ACTIVE	SOIC	D	8	2500
REF02BP	ACTIVE	PDIP	P	8	50
REF02BU	ACTIVE	SOIC	D	8	100
REF02BU/2K5	ACTIVE	SOIC	D	8	2500

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

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